

Power Sources

by:

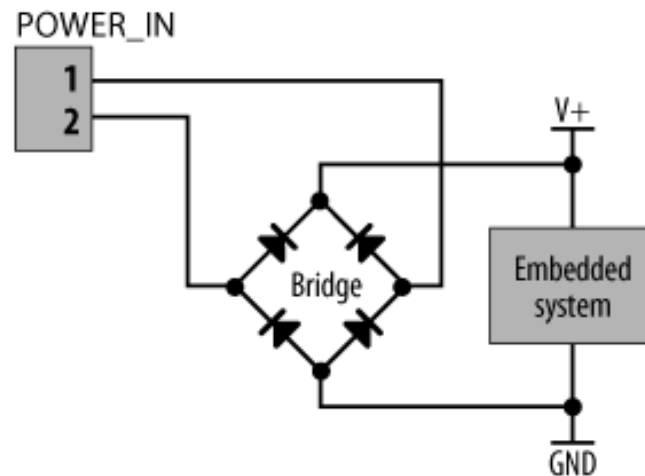
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The Stuff Out of the Wall

- What comes down the "pipe" is AC and is far too high a voltage to be of immediate use to a digital system. It must be converted to a DC voltage of significantly lower magnitude. There are plenty of solutions for doing this.
- AC adaptors (also known as plug packs or sometimes power bricks) are the little black boxes that come with your cell phone and a host of other appliances. They are a cheap, easy, and reliable solution and can be purchased from any good electronics vendor.
- Typically, they will provide an output voltage somewhere in the range of +5 VDC to +12 VDC and can supply a current of up to a few Amps, depending on the particular plug pack.

The Stuff Out of the Wall

- A better way is to incorporate a bridge rectifier as part of your design. That way, the polarity of the power source makes no difference. The input power is DC, but the polarity of the connection makes no difference. The embedded system uses the output of the rectifier as its power source and has internal voltage regulation.



Batteries

- Batteries are easy to use. The only caveat is to ensure that the battery (or batteries) you have chosen can supply enough current at the right voltage. With the right choice of battery and a carefully designed system, you can achieve extended operation over very long periods.
- A poorly designed system can drain a battery in minutes. A poorly chosen battery unable to supply sufficient current will result in erratic operation, or may result in the system being unable to start at all.

Low Power Design

- There are several ways you can reduce the power consumption in your embedded system.
 - The use of low-power devices is the most obvious place to start.
 - The power consumption of different chips varies considerably, and there are many low-power variants of common devices available.
 - RISC processors often have lower power consumption than comparable CISC processors, so they are often used in preference to CISC in low-power applications.
 - The PIC and AVR microcontrollers can have current draws of less than 5 mA (and as low as 10 nA when in sleep mode).

Regulators

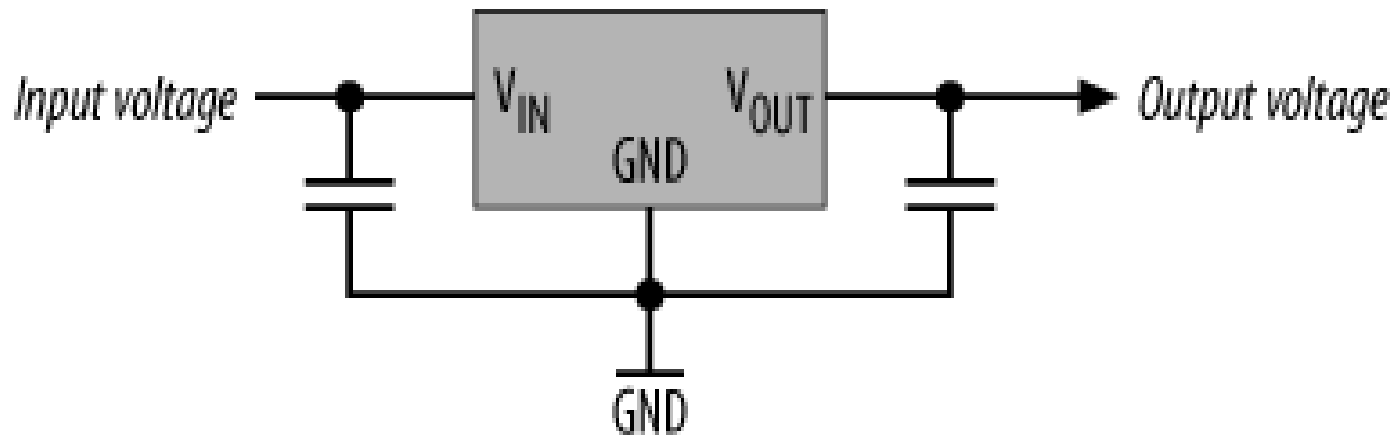
- A voltage regulator is a semiconductor device that converts an input DC voltage (usually a range of input voltages) to a fixed output DC voltage. They are used to provide a constant supply voltage within a system.
- The types of regulators we will look at are termed DC-DC converters. They take an unregulated DC voltage (often over a range of possible voltages) and provide a constant DC voltage output of a fixed value.

Regulators

- There are three types of DC-DC converters:
 - *linear regulators*, which produce lower voltages than the supply voltage;
 - *switching regulators* that can step up (boost), step down (buck), or invert the input voltage; and
 - *charge pumps*, which can also step up, step down, or invert the supply voltage, but with limited current-drive capability.

Regulators

Linear regulators



Regulators

Switching regulators get their name because they switch a power transistor (MOSFET) at their output.

- They tend to be more efficient than linear regulators in converting the input voltage to the output voltage.
- In other words, they waste less power during the conversion process.
- However, their drawback is that they require more external components (such as an inductor and diode) and therefore take up more space.
- They also typically cost more and generate far more noise than linear regulators.
- Unlike linear regulators, they can step up a voltage as well as stepping one down, and they can also invert.

Regulators

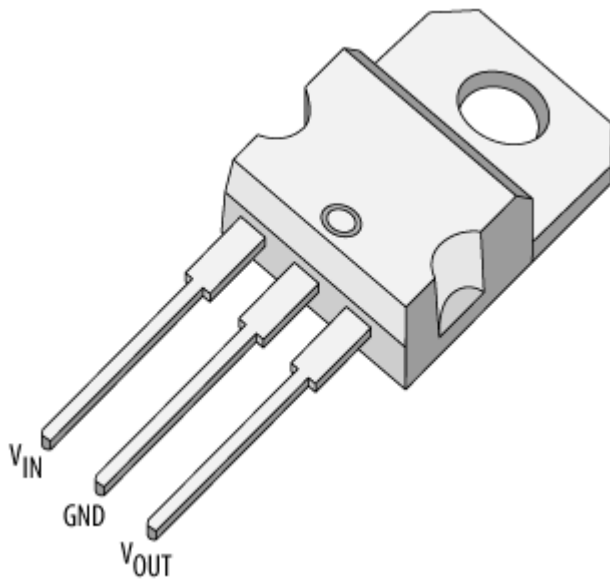
Charge pumps, like switching regulators, can step up, step down, or invert voltages. Unlike switching regulators, they require no external inductor. However, due to their limited capacity to supply current, they are not commonly used.

LM78xx Regulators

- The most commonly used are the LM78xx linear regulator series made by several manufacturers such as Fairchild (<http://www.fairchildsemi.com>), Semelab (<http://www.semelab.co.uk>), and ST Microelectronics (<http://www.st.com>).

LM78xx Regulators

- They typically come in a TO-220 package and have a metallic attachment point for a heatsink, such as the one shown below. The regulator is normally mounted flat against the circuit board, and the pins are bent 90 degrees downward.

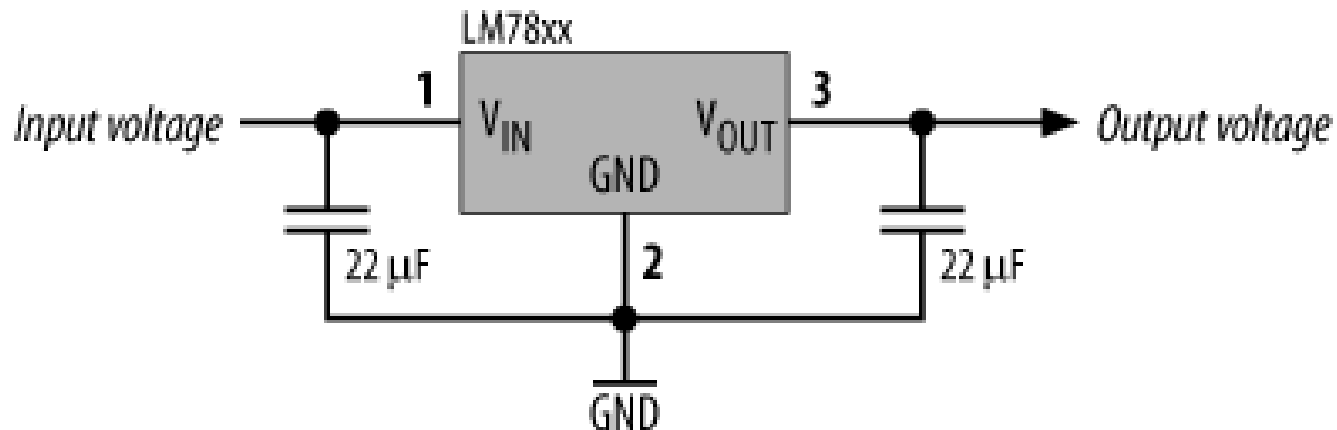


LM78xx Regulators

Part	Output (V)	Input range (V)
LM7805	5	7–25
LM7806	6	8–25
LM7808	8	10.5–25
LM7809	9	11.5–25
LM7810	10	12.5–25
LM7812	12	14.5–30
LM7815	15	17.5–30
LM7818	18	21–33
LM7824	24	27–38

LM78xx Regulators

- The LM78xx is simple to use. Decoupling capacitors (nominally between 10 μF and 47 μF) are required on the input (pin 1) and output (pin 3), as shown below. Pin 2 is connected to ground.
- For negative output voltages, use an LM79xx regulator. It's used in exactly the same way as an LM78xx.



Electrical Noise and Interference

- Digital systems are inherently analog in operation. Digital signals suffer degradation and noise due to analog effects present in the system. Spurious noise or reflections from nearby electrical machinery or radio transmissions can induce signals within your circuit that can cause false events to occur, or even prevent a digital system from functioning at all.
- *Electromagnetic interference (EMI)* is noise generated by sources external to the embedded system. Some examples of EMI are motors, switches in power consumption, fluorescent lighting, RF emissions, and electrostatic discharges. All can be significant sources of noise. For example, turning on or off a machine with an electric motor can cause a 1000 V spike on the AC power-supply line.

